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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine
233 Forestry Bldg., Colo. A & M
Fort Collins, Colorado

Black Hills Beetle Survey Improvement Study

Line Project I-c-1-15: Studies of Methods of Improving the Accuracy and General Efficiency of Bark Beetle Surveys

A CORRELATION ANALYSIS OF VARIABLES AFFECTING THE SAMPLING ERRORS OBTAINED FROM PARTIAL SAMPLES OF BEETLE-INFESTED PONDEROSA PINE STANDS - 1951

Introduction: For many years surveys of ponderosa pine stands have been made for the purpose of estimating the number of trees infested with Black Hills beetles (Dendroctonus ponderosae Hopk.). Records show that, as a whole, on large areas (5,000 ± acres) estimates have been very good. However, on moderate-sized and small areas, often the estimates have been far removed from the actual number of trees infested. This has been one of the drawbacks in estimating. Very little has been done to improve procedures because of the lack of funds to make survey studies. Sometimes, under pressure from outside interests, estimates have been broken down to include such small blocks that a survey of 50 percent or more would have been necessary to obtain an accurate figure. A survey should be made on a specific acreage to obtain an estimate with a reasonable amount of accuracy. A policy should be adopted whereby small blocks within the survey area would be delineated but no breakdown of the estimate for those blocks would be given. If a further breakdown is required by the forest managing agency for operational purposes, the benefits must be weighed with the extra cost of the survey.

On some of the surveys of very large acreages, estimates have been made that could be called "too accurate". In other words, a great deal of money has been spent on very intensive surveys when a survey of lower percent coverage would have resulted in an estimate with very little more error.

Before commencing a survey, one should be able to decide just how much coverage he will need to obtain an estimate with a desirable accuracy. Probably the easiest way to obtain the value needed is with a group of curves in which the percent of accuracy is plotted against the variables which affect that accuracy. There are three easily measurable factors which affect the accuracy of bark beetle surveys. These are: (1) the acreage of the survey area, (2) the percentage of survey applied, and (3) the infestation rate in trees per acre. There are other factors of importance for consideration, but none of these have been properly measured for application to curves or tables.

Procedure: During 1950 and 1951, surveys were made on the Roosevelt National Forest using 1/5-acre plots at 2 1/2-chain intervals along equally-spaced parallel lines. The spacing of the lines varied so that survey coverages ranged from 2.50 to 10.00 percent. Sizes of the various areas ranged from 475 to 14,488 acres and the infestation rates varied from 0.05 to 2.60 trees per acre.

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Analysis: The sampling error in percent was computed for each of the areas and a table of least squares was set up. By analysis, several of the confounding values and squared values of the variables were proved insignificant. A final regression formula was calculated with all variables significant. This formula was:

$$Y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_2^2$$

where:

Y = Sampling error in percent

x_1 = Percent of coverage

x_2 = Acreage of area

$b_0 = 94.4625$

$b_1 = -2.981187$

$b_2 = -0.0141862$

$b_3 = 0.0000007295$

Values of Y, x_1, x_2, and x_2^2 were substituted in the formula and the points needed for the curves were computed. The infestation rate did not prove to be significant in this analysis. This was probably because of the low range of rates and because of the unvarying infestation pattern characteristic of Black Hills beetle attacks. The pattern in the area of heaviest infestation retained the definite group pattern of light infestations.

Conclusions: Ways to save on surveys can be readily seen in the curves presented. For instance, on a 10,000-acre area, a 1.25-percent cruise will provide practically the same accuracy that can be obtained with a 2.50-percent cruise. A survey made using one of the curves as a basis should not be expected to provide results that will coincide exactly with the curve. A curve calculated by regression analysis is perfectly fitted and represents the means of many observations.

The curves will be of great usefulness in surveys of ponderosa pine in the central Rocky Mountains and they are submitted with the hope that they will be of use to survey personnel in other regions. After completion of surveys this fall, additional data will be available for further testing the curves. It is hoped that confidence bands for the individual curves can be worked out.

Submitted by,

Fred B. Knight

Fred B. Knight
Entomologist
May 12, 1952

cc: Beal
All Stations

Expected Mean Sampling Errors in Percent
for
Stands of Beetle-Infested Ponderosa Pine

(Tally of infested trees on 1/5-acre plots at 2 1/2-chain intervals on equally-spaced parallel lines)

Confidence at the 68-percent level